737

RUTIN IN EUCALYPTUS SPECIES*

By C. F. Krewson, C. S. Fenske, Jr., J. F. Couch** and J. Naghski

IN our search for a domestic source of rutin other than tobacco, which has a low rutin content (0.5%) and is expensive, we examined many species of plants. Of these, buckwheat (*Fagopyrum spp.*) containing from 2 to 7% of rutin (2, 8, 9), *Sophora japonica,* containing from 13 to 23% (3), and *Eucalyptus macrorrhyncha* appeared to be the most promising sources. At present, all three are used commercially for the production of rutin.

We have examined the leaves of 21 species of *Eucalyptus* growing in California. Only one of the species, *E. macrorrhyncha* F. v. M., contained rutin. This specimen was a mature tree in Golden Gate Park, San Francisco, California.

Rutin was first reported in *E. macrorrhyncha* by J. H. Maiden (4) and later, in 1898, by Henry G. Smith (13, 14), who named it "myrticolorin", believing it was a new quercetin glycoside. It was pointed out by Schmidt in 1908 (12) that myrticolorin was probably identical with rutin, and this was later confirmed by Perkin (10). Rodwell (11) found 6.8 to 11% of rutin in the leaves of *E. Youmani* Blakely and McKie, a species not available to us for examination.

E. macrorrhyncha F. v. M. (1, 6), often spelled *macrorhyncha,* is native to Australia. It is described (1) as a small to medium-size tree with a characteristic stringy bark, which is persistent on the stems and large branches. Because of this characteristic, it is known as the "red stringybark" of New South Wales and the "ordinary stringybark" of Victoria. In Australia it is essentially a mountain species growing on comparatively sterile mountain ranges on white, acid, poor soil and on granite.

Although the eucalyptus are native to Australia, many species have been introduced into California, in locations with climatic and soil conditions similar to those of their native habitat. Concerning these

* Eastern Regional Research Laboratory, Philadelphia 18, Pennsylvania, One of the laboratories of the Bureau of Agricultural and Industrial Chemistry, Agricultural Research Administration, United States Department of Agriculture.

** Deceased.

cultivated specimens in the United States, McClatchie (5) states that ". . . the specimens growing in the Southwest do not yet give promise of attaining great size, due probably to being planted at too low an elevation". He continues, "The tree is a promising one for a forest cover for mountain ranges of the Southwest." Thus there exists the possibility that *E. macrorrhyncha* may be grown here as a domestic source of rutin. The feasibility will depend on the economics of harvesting the leaves and on the time required for the plants to be brought into production. Some data on the effect of age of the trees on the rutin content of their leaves are presented in this paper.

Experimental

The rutin and moisture contents were determined according to the method of Naghski et al. (7). Table I shows the rutin contents of leaves from young plants and those from a mature *E. macrorrhyncha* tree growing in the vicinity of San Francisco.

TABLE I

RUTIN CONTENT OF LEAVES FROM EUCALYPTUS MACRORRHYNCHA GROWN IN VICINITY OF SAN FRANCISCO, CALIFORNIA

Date Collected	Age of Trees, Months	Moisture, %	Rutin, % [a]
Oct. 1946	Mature tree	42.3	12.8
May 1948	6 [b]	64.6	2.1
Aug. 1948	9	67.4	11.9
Nov. 1948	12	64.0	8.1
Nov. 1948	14	6.8 [c]	9.6
Nov. 1948	14	6.7 [c]	10.2
Nov. 1948	14	6.0 [c]	9.0
Nov. 1948	14	7.0 [c]	9.4
June 1949	19	65.3	9.2
Oct. 1949	23	63.9	4.9

Except for the leaves from the seedlings grown in the greenhouse, and the one sample from 23-month-old plants collected in October, the rutin content of the leaves from young plants is almost as high as

[a] Moisture-free basis
[b] Grown in greenhouse
[c] Samples air-dried immediately after they were collected

that of the leaves from the mature tree. In Australia, Rodwell (11) observed that leaves from young regrowth from cut stumps contained only 2 to 5% of rutin and that leaves from coppice had a lower rutin content than those from mature trees in the same area.

Table II shows the rutin content of leaves from Australian *E. macrorrhyncha* received in three different years.

TABLE II

RUTIN CONTENT OF LEAVES OF EUCALYPTUS MACRORRHYNCHA OBTAINED FROM AUSTRALIA

Year Collected	Description [a]	Moisture, %	Rutin, % [b]
1946	Matured leaves from main branches	7.9	13.7
1946	Young leaves from main branches	8.4	23.1
1946	Leaves from young shoots	8.2	11.9
1947	Leaves and small twigs	8.2	8.0 [c]
1947	Leaves and twigs	12.1	8.0
1948	Leaves and twigs	8.5	7.7

The young leaves collected from main branches were exceptionally high in rutin, containing 23.1 percent whereas mature leaves contained only 13.7 percent. The low content of rutin of the sample obtained in 1947 and 1948 was due to the dilution effect of the twigs, which contained only small amounts of rutin. Analysis of a sample of young twigs showed 4.0% rutin, whereas none was found in mature material. Rodwell (11) observed a similar relationship between the age of the leaves and the rutin content. He also found that the youngest twigs contained about 6% rutin but that the content decreased as the stems matured.

In addition to *E. macrorrhyncha* the leaves of the following twenty species of *Eucalyptus,* collected from specimens growing on the campus of Stanford University, Palo Alto, California, were examined and found to contain no rutin:

E. baueriana Schau.	*E. leucoxylon* F. v. M.
E. botryoides Sm.	*E. paniculata* Sm.
E. cornuta Labill.	*E. polyanthemos* Schau.

[a] All samples air-dried
[b] Moisture free basis
[c] Sample analyzed by extraction with boiling water

E. corynocalyx F. v. M.
E. costata Br. aff.
E. crebra F. v. M.
E. eugenioides Sieb.
E. ficifolia F. v. M.
E. globulus Labill.
E. goniocalyx F. v. M.
E. robusta Sm.
E. rostrata Schl.
E. rudis Endl.
E. salmonophloia F. v. M.
E. sideroxylon Cunn.
E. tereticornis Sm.
E. viminalis Labill.

Rodwell (11) examined the following five other species and found no rutin:

E. dives
E. obliqua Messmate
E. capitellata Sm.
E. tinghaensis
E. muelleriana Howitt

Summary

Leaves from twenty-one species of *Eucalyptus* growing in California were examined for rutin. Only one, *Eucalyptus macrorrhyncha* F. v. M., contained rutin. The rutin content ranged from 2.1% in the leaves from seedlings to 23.1% in young leaves from a mature tree. The rutin content of leaves from one to two-year-old trees was comparable with that of the mixed leaves from mature trees.

Acknowledgments

The authors wish to thank the following for their assistance in securing the samples of *Eucalyptus* used in this investigation: F. DeEds, Western Regional Research Laboratory, Albany, California; M. W. Talbot, S. N. Wyckoff and N. T. Mirov, Forest Service, U. S. Department of Agriculture, Berkeley, California; H. A. Spoehr and D. D. Keck of the Division of Plant Biology, Carnegie Institution of Washington, Stanford University, California; J. L. Gerod, Office of the Park Commissioners, San Francisco, California; W. Hartley, Division of Plant Industry, and M. F. Day, Division of Economic Entomology, Council for Scientific and Industrial Research, Canberra, Australia.

BIBLIOGRAPHY

(1) Blakely, W. F.: "A Key to the Eucalypts," The Worker Trustees, St. Andrew's Place, Sydney, Australia, 1934.

(2) Couch, J. F., Naghski, J., and Krewson, C. F.: *Science 103,* 197 (1946).

(3) Couch, J. F., Naghksi, J., and Krewson, C. F.: *J. Am. Chem. Soc., 74,* 424 (1952).

(4) Maiden, J. H.: *J. and Proc. Roy. Soc. N.S.W. 21,* 250 (1887); cited by Rodwell (11).

(5) McClatchie, A. J.: "Eucalypts Cultivated in the United States", *U. S. Dept. Agr., Bur. Forestry, Bul. 35,* p. 106 (1902).

(6) Mueller, F. von: Eucalyptographia. Dec. 1. Melbourne (1879).

(7) Naghski, J., Fenske, C. S., Jr., Krewson, C. F., and Couch, J. F.: "Determination of Rutin in Plant Materials", U. S. Dept. Agr., Bur. Agr. and Ind. Chem., AIC-236 (Eastern Regional Research Laboratory), (1949).

(8) Naghski, J., Brice, B. A., and Krewson, C. F.: This journal, *124, 297* (1952).

(9) Naghski, J., Krewson, C. F,, Porter, W. L., and Couch, J. F.: *J. Am. Pharm. Assoc., Sci. Ed., 39,* 696 (1950).

(10) Perkin, A. G.: *J. Chem. Soc. 97,* 1776 (1910).

(11) Rodwell, C. N.: *Nature 165,* 773 (1950).

(12) Schmidt, E.: *Arch. Pharm. 246,* 214 (1908).

(13) Smith, H. G.: *J. and Proc. Roy. Soc. N.S.W. 31,* 179, 377 (1897); cited by Rodwell (11).

(14) Smith, H. G.: *J. Chem. Soc. 73,* 697 (1898).